

Circular Parachute

BACKGROUND OF THE INVENTION

1. Technical Field

[01.00] This invention relates generally to parachutes, and more particularly to a circular parachute.

2. Description of Related Art

[02.00] A typical circular parachute includes a canopy to which a set of suspension lines is attached. The suspension lines connect the canopy to a harness that attaches to a person, cargo, or other load. Air inflates the canopy during descent and the drag provided reduces speed.

[03.00] The canopy of a circular parachute (i.e., a round parachute) is commonly made of a circularly shaped nylon fabric (i.e., the canopy fabric). The canopy of the flat circular type has an outer perimeter that forms a circular configuration when the canopy is laid flat upon the ground. When fully inflated, the canopy usually takes the shape of a hemispherical cap, although in some cases, the cap is slightly conical and in others, slots or concentric gaps are provided in the canopy that enhance stability. A circularly shaped central opening is often provided in the canopy to form a vent at the apex of the canopy. The circularly shaped marginal edge portion of the canopy along the perimeter of the vent is sometimes referred to as the "vent band" of the canopy, while the

1 circularly shaped marginal edge portion of the canopy along the outer
perimeter is sometimes referred to as the "skirt band."

[04.00] Suspension lines nowadays are commonly nylon too, although
5 some use materials available under the trademarks KEVLAR and
SPECTRA. They function to suspend the load from the canopy. For
canopies having a vent, vent suspension lines are attached to the vent
band. With the canopy descending vertically and fully inflated, the vent
suspension lines converge downwardly in a vent suspension line
10 confluence extending to a single, vertically extending, vent centerline.
Main suspension lines are attached to the skirt band. With the canopy
descending vertically and fully inflated, the main suspension lines
converge downwardly in a main suspension line confluence extending with
the vent centerline to a suspension line junction that is connected to a
15 harness for the load.

[05.00] One recognized problem common to the canopy and the
suspension lines appears as the parachute is deployed. The suspension
lines unfold until they are fully stretched. Then, the canopy unfurls and
20 begins inflating. As that occurs, sudden shocks and other large forces are
produced that can cause random failures modes, including structural
failures of the canopy and/or suspensions lines. Various techniques exist
to help overcome this problem, but improvement remains desirable. Thus,
a need exists for a better circular parachute configuration.

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SUMMARY OF THE INVENTION

[06.00] This invention addresses the concerns outline above by providing a circular parachute having cascaded suspension lines. The suspension lines are cascaded in the sense that each main suspension line includes a lower segment that branches upwardly into two upper segments. That arrangement doubles the number of suspension lines connected to the skirt band of the canopy with one-half the number of lines at the suspension line junction, thereby distributing the peak opening forces more evenly along the skirt band.

[07.00] There is a reduced potential of suspension lines tensioning at different times as experienced in an asymmetrical deployment. The advantage of line cascading is realized through a reduced number of suspension lines to the attach point and a reduction in distance that one upper suspension line can tension before another if on the same lower suspension line (the length of the upper suspension line is less than the total suspension line length). Both of these contribute to the reduction of asymmetrical deployments.

[08.00] To paraphrase some of the more precise language appearing in the claims, a parachute constructed according to the invention includes a circularly shaped canopy having a skirt band and a plurality of main suspension lines connected to the skirt band. According to a major aspect of the invention, each main suspension line is cascaded in the sense that it includes a lower main suspension line segment that branches

1 into at least two upper main suspension line segments. In one
embodiment, ten lower main suspension line segments branch into twenty
upper main suspension line segments connected to the skirt band. The
ten main suspension lines converge from the skirt band toward a
5 suspension line junction.

[09.00] The circular parachute may include a vent band on the circularly
shaped canopy and a plurality of cascaded vent suspension lines. In one
embodiment, ten lower vent suspension segments branch into twenty
10 upper vent suspension line segments connected to the vent band, and the
ten vent suspension lines converge from the vent band toward a vent
centerline that extends to the suspension line junction.

[10.00] According to another aspect of the invention, there is provided
15 means for slowing the opening of the canopy, including a generally planar
reefing device defining a plurality of openings through which the main
suspension lines extend (i.e., suspension-line-receiving openings).
Preferably, the reefing device includes a strip of material folded into five
strip segments arranged in a five-point star configuration having five strip
20 segment junctions uniformly spaced apart at the points of the five-point
star configuration. Five eyelets secure the five strip segment junctions,
each of the eyelets extending through a respective one of the strip
segment junctions to form the five suspension-line-receiving openings. In
one reefing device embodiment, the five strips segments are portions of
25 a nylon strap, each strap segment measuring about seventeen inches

1 long, and the strap segments are secured with eyelets in the form of brass
grommets.

5 [11.00] Thus, the invention provides a cascaded suspension line
arrangement that distributes the peak opening forces for a more even load
distribution by the suspension lines that reduces the peak opening forces.
In addition, the cascaded suspension lines reduce the number of lines to
the attachment point by fifty percent or more. Furthermore, the use of
cascaded suspension lines provides the ability to integrate suspension line
10 materials with dissimilar physical properties (primarily elongation) in the
segmented suspension lines in order to thereby tailor the opening
characteristics of the parachute as desired. Moreover, the use of
cascaded suspension lines provides an additional force component to
control the descent of the slider (i.e., the reefing device). The angle of the
15 upper suspension line segments that initiate the descent of the slider
provide the ability to control the peak opening forces at low and high
speeds. The following illustrative drawings and detailed description make
the foregoing and other objects, features, and advantages of the invention
more apparent.

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BRIEF DESCRIPTION OF THE DRAWINGS

25 [12.00] FIG. 1 of the drawings is a diagrammatic elevation view of a
circular parachute constructed according to the invention, shown
descending vertically with the canopy fully inflated;

1 [13.00] FIG. 2 is a diagrammatic isometric view of the circular parachute with the canopy fabric omitted in order to emphasize the skirt band, the main suspension lines, the vent band, and the vent suspension lines;

5 [14.00] FIG. 3 is a diagrammatic bottom view of the skirt band, the main suspension lines, the vent band, and vent suspension lines as viewed looking upwardly from the suspension line junction;

10 [15.00] FIG. 4 is an enlarged diagrammatic isometric view of just the vent band and the attached vent suspension lines, with the vent centerline foreshortened for illustrative reasons;

[16.00] FIG. 5 is a top plan view of a reefing device for slowing the opening of the canopy; and

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[17.00] FIG. 6 is an isometric view of the reefing device showing the vent centerline strung through the central opening and the ten lower suspension lines strung through the five eyelets.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

[18.00] FIGS. 1-5 of the drawings show various aspects of a circular parachute 10 constructed according to the invention. Generally, the

1 parachute **10** includes a circularly shaped canopy **11** and ten main
suspension lines **12**. Only one of the ten main suspension lines **12** is
identified with a reference numeral in FIGS. **1**, **2**, and **3** for illustrative
purposes. The other nine main suspension lines are similar to the one
5 that is identified.

[19.00] The canopy **11** is composed of a parachute grade of nylon fabric
or other suitable material (i.e., the canopy fabric) that is depicted in FIG. **1**
by the shaded portion of the parachute **10**. The canopy fabric is omitted
10 from FIGS. **2**, **3**, and **4** for illustrative purposes, however, in order to
emphasize the main suspension lines **12**. The main suspension lines **12**
may be of nylon composition also, and they are depicted by bold lines in
FIGS. **1-4**. The canopy **11** includes a known sort of circularly shaped skirt
band **13** to which the main suspension lines **12** are connected in a known
15 manner, with the main suspension lines **12** extending from the skirt
band **13** to a known type of suspension line junction **14** (FIGS. **1-3**) that
may in turn be connected in a known manner to a load (not shown).

[20.00] The canopy **11** and main suspension lines **12** may be similar in
20 some respects to existing parachute components and they are sized
according to the intended parachute application. As the parachute **10**
descends vertically with the canopy **11** fully inflated as depicted in FIG. **1**,
the canopy **11** and the main suspension lines **12** are disposed
symmetrically about a vertical central axis **15**. The main suspension

1 lines **12** converge downwardly from the skirt band **13** toward a main
suspension line confluence at the suspension line junction **14**.

5 [21.00] According to a major aspect of the invention, each main
suspension line **12** is cascaded. It is cascaded in the sense that it
includes a lower segment **12A** that branches upwardly at a junction **12B**
into at least two upper segments **12C** and **12D** (FIGS. 1-3). The two
upper segments **12C** and **12D** are connected to the skirt band **13** at
skirt band attachment points **16** and **17**, extending downwardly from
10 the skirt band attachment points **16** and **17** in converging relationship to
each other to the junction **12B** where they are tied to or otherwise suitably
connected to the lower segment **12A**. Preferably, the skirt band
attachment points **16** and **17** (and the other eighteen unidentified skirt
band attachment points) are uniformly space apart along the skirt band **13**
15 at 18-degree intervals as illustrated in FIG. 3. The net effect of that entire
arrangement of cascaded main suspension lines **12** is to provide a better
force distribution with fewer lines connected to the suspension line
junction **14** as stated previously.

20 [22.00] In addition to the foregoing features, the canopy **11** of the
illustrated parachute **10** includes a vent **20** (a circular central opening) that
is identified in FIGS. 1 and 2 by an arrow **20**. The vent **20** is defined by
a circularly shaped vent band **21** portion of the canopy **11** that is identified
in FIGS. 2, 3, and 4, with FIG. 4 being an enlarged diagrammatic view of
25 just the vent band aspects of the parachute **10**.

1 [23.00] A plurality of ten vent suspension lines **22** are connected to the
vent band **21**, only one of the ten vent suspension lines **22** being identified
with a reference numeral in FIGS. **1**, **2**, **3**, and **4** for illustrative purposes.
The other nine vent suspension lines are similar to the one that is
5 identified, converging downwardly from the vent band **21** toward a vent
suspension line confluence at a vent suspension line junction **23** that is
connected to a vent centerline **24**. The vent suspension lines **22** are tied
to or otherwise suitably connected to the vent centerline **24** at the
junction **23** (e.g., finger-locked loops), and the vent centerline **24** extends
10 downwardly from there to the suspension line junction **14**.

[24.00] Similar to the main suspension lines **12**, each vent suspension
line **22** is cascaded in the sense that it includes a lower vent suspension
line segment **22A** that branches upwardly at a vent suspension line
15 junction **22B** into at least two upper vent suspension line segments **22C**
and **22D** (FIGS. **4**). The two upper vent suspension line segments **22C**
and **22D** are connected to the vent band **13** at vent band attachment
points **24** and **25**, extending downwardly from the vent band attachment
points **24** and **25** in converging relationship to each other to the vent
20 suspension line junction **22B** where they are tied to or otherwise suitably
connected to the lower segment **22A**. Preferably, the vent band
attachment points **24** and **25** (including the eighteen unidentified vent band
attachment points) are uniformly space apart along the vent band **13** at
18-degree intervals as illustrated in FIG. **4**.

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1 [25.00] Turning now to FIGS. 5 and 6, they show various details of a reefing device in the form of a slider 30. It functions as means for slowing the opening of the canopy 11. Doing so with a reefing device is a known technique and reference may be made to U.S. Patent 4,863,119
5 for some related details and further information. The slider is more effective during high speed deployments and does not slow the opening too much during slow speed deployments.

[26.00] The slider 30 is a generally planar device fabricated from a strip
10 of material (e.g., a nylon strap) that is folded into five strip segments 31, 32, 33, 34, and 35 (FIG. 5) that are arranged in a five-pointed star configuration. Each strip segment 31-35 is preferably of uniform length and preferably in the range of about sixteen inches to about eighteen inches for the illustrated parachute 10. The illustrated strip
15 segments 31-35 measure about seventeen inches long and about 1.75 inches wide, although the slider 30 can be scaled according to the diameter of the parachute so that dimensioning may vary within the scope of the broader claims.

20 [27.00] As shown in FIG. 5, the strip segments 31 and 32 are connected together at a strip segment junction 42 (at a fold in the nylon strap) by an eyelet in the form of a brass grommet 52 that defines a suspension-line-receiving opening 62. The grommet 52 may, for example, have an outside diameter measuring 1.125 inches and an inside diameter
25 measuring about 0.675 inches. Similarly, the strip segments 32 and 33 are connected together at a strip segment junction 43 by a grommet 53

1 that defines an opening 63, the strip segments 33 and 34 are connected
together at a strip segment junction 44 by a grommet 54 that defines an
opening 64, the strip segments 34 and 35 are connected together at a
strip segment junction 45 by a grommet 55 that defines an opening 65,
5 and the strip segments 35 and 31 are connected together at a strip
segment junction 41 by a grommet 51 that defines an opening 61
Stitching 71, 72, 73, 74, and 75 helps secure the strip segments 31-35.

[28.00] So constructed, the slider 30 may be easily and inexpensively
10 fabricated, and it works well with the ten main suspension lines 12
described above for the parachute 10. As shown in FIG. 6, each one of
five pairs 81, 82, 83, 84, and 85 of the lower segments 12A of the ten
main suspension lines 12 are strung through a respective one of the
grommets 51-55 (i.e., through the five suspension-line-receiving
15 openings 61-62 defined by the grommets), and the vent centerline 24 is
strung through a central opening in the slider 30 defined by the strip
segments 31-35. As the canopy 11 unfurls, the slider 30 slows the
opening of the canopy 11 in a known manner, eventually moving
downwardly along the main suspension lines 22 toward the suspension
20 line junction 14 to the position shown in FIG. 6.

[29.00] Thus, the invention provides a circular parachute having
cascaded suspension lines so that the number of suspension lines
connected to the skirt band of the canopy increases while the number at
25 the suspension line junction decreases. In addition, a slider is provided

1 in a five-pointed star configuration can be easily and inexpensively
fabricated for use with the parachute. Although an exemplary embodiment
has been shown and described, one of ordinary skill in the art may make
many changes, modifications, and substitutions without necessarily
5 departing from the spirit and scope of the invention. Some
parachutes (primarily personnel parachute systems), for example, have
multiple attach points (usually two to four attach points on the risers on
personnel parachute systems), and the invention may be applied to
those type of parachutes also within the scope of the broader claims.
10 A ten-point star slider can be constructed with two five-point stars stacked
on top of one another. As parachutes increase in diameter, the number
of suspension lines increases (e.g., a 100-foot diameter parachute is likely
to have about one hundred suspension lines). All such variations,
including various numbers of suspension lines and slider grommets, are
15 intended to fall within the scope of the broader claims.

[30.00] What is claimed is:

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